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General Evaluation of Amasya Provincial Renewable Energy Power Plant Installed Capacity and TEİAŞ Substation Power

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Abstract

The renewable energy production sector has made rapid progress in the province of Amasya as well as in the world, and the rate of installed power in the energy production sector is increasing rapidly by growing continuously. Having reached the level of 99,820 megawatts (MW) in Turkey at the end of December 2021, the total installed power of Turkey became 103,276 MW at the end of October 2022. While a total of 995 MW of installed power was commissioned in October, 159 MW of this installed power was provided by solar power plants. In the same period, while the total net installed power of wind power plants increased by 108 MW, this figure was recorded as 4 MW in renewable waste power plants. In addition to these capacities, an imported coal power plant with a net capacity of 660 MW was commissioned in October.

Amasya province receives energy from a total of five substations belonging to TEDAŞ. There are a total of 11 power transformers that these substations energize the distribution network, with a total installed capacity of 500 MVA. The total installed capacity of renewable energy generation in Amasya province is 100.9 MVA, including biogas, solar energy power plant (SPP), HEPP, WPP licensed and unlicensed. Considering the annual sunshine duration and geographical conditions, Amasya is among the provinces with high wind and sunshine potential. Due to the recent wars and crises, high energy prices have had a positive effect on the industrial organizations' orientation towards renewable energy and the increase in the installed capacity of the power plants. This shows the importance given to the development of our country and energy production.

Keywords: Electricity generation, renewable energy, electricity unit price

1. Introduction

The renewable energy production sector is of strategic importance for countries. With the increase in population, industrialization, globalization, and consumption; the demand for natural sources of energy has also increased. A very significant portion of energy production in the world is obtained from fossil fuels (coal, oil and natural gas). However, some factors such as the fact that fossil fuels are limited, cause environmental problems, and make countries dependent on foreign energy sources increase the interest and demand for renewable energy sources in the world [1]. The rapid depletion of fossil fuels started to increase the tendency towards different energy sources, and this situation has brought along the search for new alternative energy sources. It does not seem possible for fossil fuel resources to ensure sustainable development in the future. Fossil-based production is both unsustainable and an alternative that is dependent on external resources [2].

Nowadays, we are in a period when electrical energy is consumed rapidly without realizing it while using electrical energy, which is the most important which is needed by many vital activities, and it is increasing day by day in terms of its need. Energy production is a very difficult task that is done by going through many stages. Many countries are very poor in terms of energy resources or have many resources but do not have the economic power to cover the cost to build facilities to use these resources. In some countries, even if they cannot find this need within their own country, they use natural gas from other countries with their economic means, coal or oil in an effort to produce electricity. In the meantime, there is a very important point; in case of any constraint or change in policies between countries, there is a

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situation where the raw material for production cannot be supplied, that is, foreign dependency. The biggest example of this situation is the Russia-Ukraine War in 2022. The natural gas purchasers from Russia from the countries that support Ukraine from the world states have been unable to supply natural gas due to the contradiction of their policies and have fallen into a state of limitation.

Countries such as France and Germany, despite being industrial and technological giants, have shut down their glass and fertilizer factories for a certain period, even government offices and schools have restricted energy use, and streetlamps have been programmed to consume less at certain hours than in previous periods. Many industrial enterprises have suspended production and are unable to employ their workers. It is a difficult situation that even countries that are in very good positions in industry and technology are currently experiencing difficulties in the crisis. Even European countries are unable to meet their energy needs at full capacity, as the production of production facilities to be built in the field of renewable energy forces certain economic levels. Even if these countries build the facilities where renewable energy sources will be used, the fact that their current economic situation is not favorable has made them unable to meet their own energy needs. Our country's projection in the field of renewable energy resources is in a very important place in the world both in terms of resources and geography.

Considering the annual sunshine duration and geographical conditions, Amasya is among the provinces with high wind and sunshine potential. The high energy prices due to the recent wars and crises have had a positive effect on the industrial organizations' orientation towards renewable energy and the increase in the installed capacity of the power plants. This shows the importance given to the development of our country and energy production.

2. Renewable Energy Sources

Renewable energy sources can be divided into 5 groups;

- Wind Energy
- Hydroelectric Power
- Solar Energy
- Geothermal Energy
- Biomass Energy

2.1. Wind Energy

Wind energy is formed by converting the kinetic energy of the air mass into mechanical energy [3]. It is the art of generating electricity from wind energy by selecting the appropriate size by considering the appropriate conditions and landforms with the installed tribunes.

2.2. Hydroelectric Power

As a term, hydroelectricity is the production of electrical energy with a turbine placed in a certain design in front of the water flowing from a high point in elevation by using the force of gravity. Hydroelectric power plants represent the facilities where this electrical energy is generated. Hydroelectric power plants simply generate electricity by lowering the water from a certain elevation and rotating the power generation generator motors.

2.3. Solar Energy

The sun is a great source of energy that energizes our world. It is also the source of renewable energy sources. Solar energy is the radiant energy released by the fusion process of hydrogen gas into helium in the sun. Being a thermonuclear reactor, the sun emits energy at various wavelengths (62 MW/m^2) and only one in two billion of the energy emitted from the entire surface of the sun reaches the Earth. The energy coming to the Earth from the sun, traveling 150 million kilometres, is approximately 15 thousand times the energy used on Earth in a year [4]. Thanks to the solar panels installed, the collected sun rays are converted into heat and electrical energy.

2.4. Geothermal Energy

Geothermal energy is a hydrothermal mass consisting of water and steam containing mostly dissolved mineral salts and gases, whose temperatures vary regionally, and which is formed by the accumulated heat formed by the accumulated heat that forms its potential with the waters in various depths of the earth's crust and fed from the basins on the earth. The systems formed by some hard rocks such as granite underground are also characterized as a geothermal energy source although they do not contain water [5]. These underground hot springs are brought to the surface of the earth and converted into electrical energy through high pressure generators.

2.5. Biomass Energy

Biomass is the total mass of living organisms of a species or a community of several species at a given time. All substances of plant and animal ori 2105 main components of which are carbohydrate compounds, are defined as biomass energy sources and the energy produced from these sources is defined as biomass energy [6]. Biomass energy is a product obtained from organic wastes by

fermentation, which, together with methane gas, can be used in different areas such as heating, electricity generation and vehicle fuel. Plant products that provide biomass energy can be reproduced as oilseed plants, sugar and starch plants, fiber plants, plant residues, cattle, sheep and poultry droppings, etc.

3. Electricity Generation in Turkey

Turkey's total installed capacity, which reached 99,820 megawatts (MW) at the end of December 2021, reached 103,276 MW at the end of October 2022. A total net installed capacity of 995 MW was commissioned in October, of which 159 MW was provided by solar power plants. In the same period, the total net installed capacity of wind power plants increased by 108 MW, while this figure was recorded as 4 MW in renewable waste energy plants. In addition to these capacities, imported coal power plants with a net capacity of 660 MW were commissioned in October. [7]

October 2022 Turkey Electricity Generation Installed Capacity Distribution					
solar energy	Geothermal Energy	Wind Energy	Biomass Energy	Hydroelectric Power	thermal energy
8,8%	1,60%	10,90%	2,10%	30,60%	45,90%

Figure 1: October 2022 Turkey Electricity Generation Installed Capacity Distribution

Number Of Power Plants And İnstalled Capacity By Primary Sources		
Primary Source	Number of Power Plants	Installed Capacity (MW)
Stream	609	8.288.2
Coal	1	405.0
Waste Heat	94	387.5
With Dam	141	23.275.2
Biomass	384	1.838.4
Natural Gas	345	25.310.1
Fuel Oil	9	251.9
Solar	9308	9.319.0
İmported Coal	16	10.373.8
Geothermal	63	1.686.3
Lignite	47	10.191.5
Lng	1	2.0
Motorin	1	1.0
Nafta	1	44746
Wind	358	11.365.6
Stone Coal	4	840.8
TOTAL	**11348**	**103.541.2**

Figure 2: TEİAŞ November 2022 Installed Capacity Report

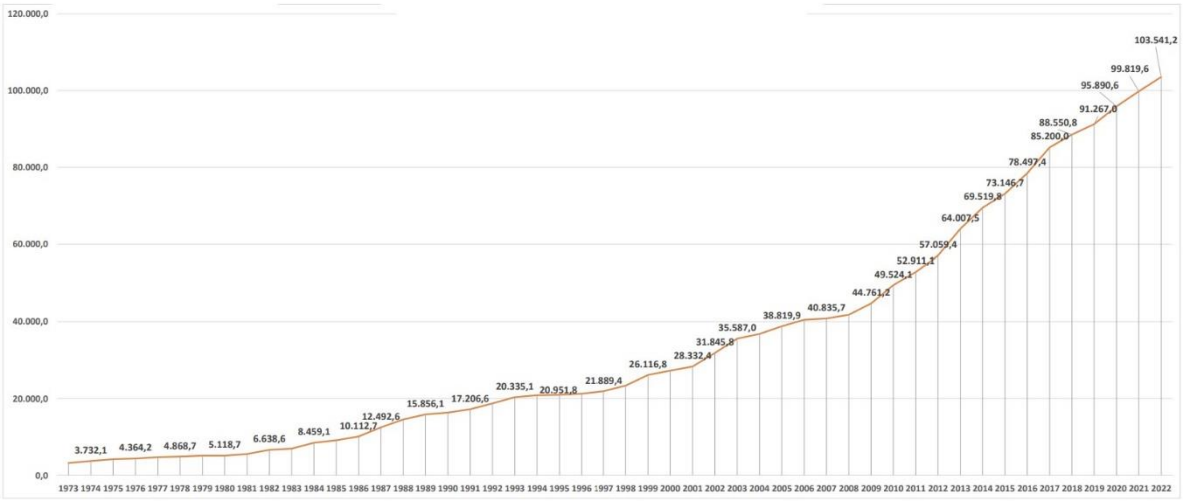

Figure 3: TEİAŞ November 2022 Installed Capacity Development

Comparatıve Monthly Gross Electrıcıty Generatıon In Turkey Compared To The Previous Year							
						Unit : GWh	
	2021			2022			
	EÜAŞ	Productıon Company + Transfer Of Operatıng Rıghts	Total	EÜAŞ	Productıon Company + Transfer Of Operatıng Rıghts	Total	Plus %
Total	49.487,5 GW	255.979,9 GW	305.467,4 GW	43.080,6 GW	256.385,8 GW	299.466,3 GW	-2,00%

Figure 4: TEİAŞ November 2022 Electricity Generation Report

4. Amasya Substation and Electricity Generation Information

Amasya province receives energy from a total of five substations belonging to TEDAŞ. There are a total of 11 power transformers that these substations energize the distribution network, with a total installed capacity of 500 MVA.

Amasya Provınce Transformer Centers Installed Power Informatıon					
Amasya TM 154 KV	Kayabaşı TM 380 KV	Merzifon TM 154 KV	Yenidere TM 154 KV	Erbaa TM 154 KV	Total
50 + 50 MVA	50 + 50 MVA	50 + 50 MVA	50 + 50 + 50 MVA	25 + 25 MVA	500 MVA

Figure 5: Amasya Province Transformer Centres Installed Power Information

In Amasya Regional Directorate, there are 1450 transformer posts belonging to the company and 1500 transformer posts belonging to private customers. The total installed power is 425.2 MVA and the peak power of the province is 112 MW.

In the light of this information, due to the increases in current electricity prices in Amasya province There is a tendency towards renewable energy production. With the recent increase in new licensed and unlicensed power plants, the installed capacity of renewable energy has reached 100,9 MW in Amasya. The figure (Figure 5) shows their rates and total installed capacity according to their classes.

Wind Energy	Hydroelectric Power	Solar Energy	Biomass Energy
9,9 MW	26,94 MW	46,18 MW	17,88 MW
10%	26%	46%	18%

Figure 6: October 2022 Amasya Power Generation Installed Capacity Distribution

GENERATION PLANTS IN AMASYA PROVINCE TOTAL INSTALLED CAPACITY AND RESOURCE INFORMATION			
SOURCE TYPE	NUMBER	INSTALLED POWER (MW)	UNDERGRADUATE STATUS
Biomass Energy	5	17,88	Licensed
Solar Energy	61	46,18	Unlicansed
Hydroelectric Power	7	26,94	5 Licensed, 2 Unlicansed
Wind Energy	2	9,9	1 Licensed, 1 Unlicansed

Figure 7: October 2022 Amasya Province License Status by Resource Type

5. Energy Consumption and Production Price Fees

	EPDK Activity-Based Tariffs Approved by the Commission and Applicable as of October 1, 2022									
	1/10/2022	Activity Based Consumer Tariffs (kr/kWh)					Total Tariffs Excluding Power Charge (kr/kWh)			
Transmission System Users	Transmission System Users Receiving Energy from the Incumbent Supply Company	Retail Single Time Energy Charge	Retail Daytime Energy Charge	Retail Peak Energy Charge	Retail Night Energy Charge	Distribution Fee	Single Time	Daytime	Puant	Night
	Consumer	370,0212	374,5341	590,2971	200,3921	0,0000	370,0212	374,5341	590,2971	200,3921
Distribution System Users	Distribution System Users	Retail Single Time Energy Charge	Retail Daytime Energy Charge	Retail Peak Energy Charge	Retail Night Energy Charge	Distribution Fee	Single Time	Daytime	Puant	Night
	Medium Voltage						Medium Voltage			
	Double Term						Double Term			
	Industry	380,5587	385,0718	600,8348	210,9296	14,7972	395,3559	399,8690	615,6320	225,7268
	Public and Private Services Sector and Other	306,5364	309,4979	479,1283	174,5300	23,0611	329,5975	332,5590	502,1894	197,5911
	Residence	188,2642	191,2551	300,1904	104,1417	22,8419	211,1061	214,0970	323,0323	126,9836
	Agricultural Activities	193,2351	195,1716	305,7077	106,8426	18,9925	212,2276	214,1641	324,7002	125,8351
	Lighting	282,8368				22,1336	304,9704			
	Single Term						Single Term			
	Industry	393,1220	397,7916	620,9517	217,6790	16,3448	409,4668	414,1364	637,2965	234,0238
	Public and Private Services Sector and Other	313,8212	316,7827	486,4131	181,8140	28,7660	342,5872	345,5487	515,1791	210,5800
	Residence	190,8544	193,8455	302,7792	106,7309	28,2039	219,0583	222,0494	330,9831	134,9348
	Agricultural Activities	196,1875	198,1240	308,6603	109,7939	23,6477	219,8352	221,7717	332,3080	133,4416
	Lighting	289,6156				27,6100	317,2256			
	Low Voltage						Low Voltage			
	Single Term						Single Term			
	Industry	405,9469	410,3792	622,3148	239,3267	25,2888	431,2357	435,6680	647,6036	264,6155
	Public and Private Services Sector and Other (30 kWh/days and below)	236,8288	329,6126	499,2428	194,6445	34,2716	271,1004	363,8842	533,5144	228,9161
	Public and Private Services Sector and Other (30 kWh/over day)	326,6517	329,6126	499,2428	194,6445	34,2716	360,9233	363,8842	533,5144	228,9161
	Residence (8 kWh/days and below)	121,0388	200,5109	309,4456	113,3962	33,5187	154,5575	234,0296	342,9643	146,9149
	Residence (8 kWh/over day)	197,5193	200,5109	309,4456	113,3962	33,5187	231,0380	234,0296	342,9643	146,9149
	Martyr Families and War Veterans	50,8633				22,7335	73,5968			
	Agricultural Activities	202,6232	207,6944	315,0966	116,2297	28,1603	230,7835	235,8547	343,2569	144,3900
	Lighting	301,7659				32,8247	334,5906			
	General Lighting	358,3300				32,8247	391,1547			

Figure 8: EPDK Activity-Based Tariffs Approved by the Commission and Applicable as of October 1, 2022

EPDK Activity-Based Tariffs Approved by the Ministry of Finance and Applicable as of January 1, 2022									
	1/1/2022	Activity Based Consumer Tariffs (kr/kWh)					Total Tariffs Excluding Power Charge (kr/kWh)			
Transmission System	Transmission System Users Receiving Energy from the Incumbent Supply Company	Retail Single Time Energy Charge	Retail Daytime Energy Charge	Retail Peak Energy Charge	Retail Night Energy Charge	Distribution Fee	Single Time	Daytime	Puant	Night
	Consumer	147,4263	149,3960	243,5779	73,3821	0,0000	147,4263	149,3960	243,5779	73,3821
Distribution System Users	Distribution System Users	Retail Single Time Energy Charge	Retail Daytime Energy Charge	Retail Peak Energy Charge	Retail Night Energy Charge	Distribution Fee	Single Time	Daytime	Puant	Night
	Medium Voltage						Medium Voltage			
	Double Term						Double Term			
	Industry	157,3709	159,3408	253,5227	83,3267	14,5454	171,9163	173,8862	268,0681	97,8721
	Trading House	179,7944	181,6169	286,0048	98,5597	22,6686	202,4630	204,2855	308,6734	121,2283
	Mesken	130,2756	132,4429	211,3815	69,3172	22,4532	152,7288	154,8961	233,8347	91,7704
	Agricultural Irrigation	134,8303	136,2335	216,3321	72,2270	18,6693	153,4996	154,9028	235,0014	90,8963
	Lighting	165,5392				21,7570	187,2962			
	Single Term						Single Term			
	Industry	156,8345	158,8053	252,9872	82,7910	16,0666	172,9011	174,8719	269,0538	98,8576
	Trading House	183,0499	184,8724	289,2603	101,8147	28,2765	211,3264	213,1489	317,5368	130,0912
	Mesken	131,3609	133,5284	212,4659	70,4019	27,7239	159,0848	161,2523	240,1898	98,1258
	Agricultural Irrigation	136,3465	137,7497	217,8485	73,7424	23,2453	159,5918	160,9950	241,0938	96,9877
	Lighting	168,5589				27,1401	195,6990			
	Low Voltage						Low Voltage			
	Single Term						Single Term			
	ndustry	166,9128	168,8825	263,0643	92,8686	24,8584	191,7712	193,7409	287,9227	117,7270
	Trading House	189,0181	190,8402	295,2280	107,7829	33,6884	222,7065	224,5286	328,9164	141,4713
	Residential (5 kWh/day and below)	79,4622	137,0507	215,9889	73,9241	32,9483	112,4105	169,9990	248,9372	106,8724
	Residential (over 5 kWh/day)	134,8829	137,0507	215,9889	73,9241	32,9483	167,8312	169,9990	248,9372	106,8724
	Martyr Families and War Veterans	31,2641				22,3466	53,6107			
	Agricultural Irrigation	139,8998	143,5746	221,4022	77,2958	27,6811	167,5809	171,2557	249,0833	104,9769
	Lighting	174,2104				32,2661	206,4765			
	General Lighting	138,2130				32,2661	170,4791			

Figure 9: EPDK Activity-Based Tariffs Approved by the Ministry of Finance and Applicable as of January 1, 2022

EPDK Activity-Based Tariffs Approved by the Ministry of Finance and Applicable as of January 1, 2021									
	1/1/2021	Activity Based Consumer Tariffs (kr/kWh)					Total Tariffs Excluding Power Charge (kr/kWh)			
Transmission System Users	Transmission System Users Receiving Energy from the Incumbent Supply Company	Retail Single Time Energy Charge	Retail Daytime Energy Charge	Retail Peak Energy Charge	Retail Night Energy Charge	Distribution Fee	Single Time	Daytime	Puant	Night
	Consumer	55,1544	55,9104	92,0586	26,7352	0,0000	55,1544	55,9104	92,0586	26,7352
Distribution System Users	Distribution System Users	Retail Single Time Energy Charge	Retail Daytime Energy Charge	Retail Peak Energy Charge	Retail Night Energy Charge	Distribution Fee	Single Time	Daytime	Puant	Night
	Medium Voltage						Medium Voltage			
	Double Term						Double Term			
	Industry	54,7497	55,5058	91,6541	26,3306	10,8794	65,6291	66,3852	102,5335	37,2100
	Trading House	59,4037	60,0904	99,4221	28,7957	16,9552	76,3589	77,0456	116,3773	45,7509
	Mesken	40,8361	41,6527	71,3956	17,8679	16,7941	57,6302	58,4468	88,1897	34,6620
	Agricultural Irrigation	53,8485	54,4682	89,8390	26,2035	13,9639	67,8124	68,4321	103,8029	40,1674
	Lighting	54,3429				16,2734	70,6163			
	Single Term						Single Term			
	Industry	54,4844	55,2408	91,3891	26,0655	12,0172	66,5016	67,2580	103,4063	38,0827
	Trading House	59,4796	60,1663	99,4981	28,8715	21,1497	80,6293	81,3160	120,6478	50,0212
	Mesken	40,1894	41,0061	70,7486	17,2210	20,7364	60,9258	61,7425	91,4850	37,9574
	Agricultural Irrigation	53,8419	54,4616	89,8324	26,1965	17,3866	71,2285	71,8482	107,2190	43,5831
	Lighting	54,4011				20,2997	74,7008			
	Low Voltage						Low Voltage			
	Single Term						Single Term			
	Industry	55,2276	55,9836	92,1319	26,8085	18,5931	73,8207	74,5767	110,7250	45,4016
	Trading House	59,9118	60,5984	99,9301	29,3037	25,1976	85,1094	85,7960	125,1277	54,5013
	Mesken	39,7629	40,5797	70,3224	16,7946	24,6441	64,4070	65,2238	94,9665	41,4387
	Martyr Families and War Veterans	14,1787				16,7144	30,8931			
	Agricultural Irrigation	54,1959	55,8187	90,1866	26,5506	20,7044	74,9003	76,5231	110,8910	47,2550
	Lighting	54,8099				24,1338	78,9437			
	General Lighting	33,7854				24,1338	57,9192			

Figure 10: EPDK Activity-Based Tariffs Approved by the Ministry of Finance and Applicable as of January 1, 2021

Residential Tariff Group;

While on January 1, 2021, the kWh price of electricity was 64.40 kurus, on January 1, 2022, the kWh price for daily consumption of 5 kWh and below increased by 174% to 112.41 kurus, and for daily consumption of 5 kWh and above, the kWh price increased by 260% to 167.83 kurus. On October 1, 2022, the kWh price for daily consumption of 8 kWh and below increased by 240% to 154.55 kurus, and for daily consumption of 8 kWh and above, the kWh price increased by 358% to 231.03 kurus. (Price increase rates are calculated with reference to January 1, 2021).

Agricultural Irrigation Tariff Group;

On January 1, 2021, the kWh price of electricity was 74.90 kurus, while on January 1, 2022, the kWh price increased by 223% to 167.58 kurus. On October 1, 2022, the kWh price increased by 308% to 230.78 kurus. (Price increase rates are calculated with reference to January 1, 2021).

In the Commercial Tariff Group;

On January 1, 2021, the kWh price of electricity was 85.10 kurus, while on January 1, 2022, the kWh price increased by 261% to 222.70 kurus. On October 1, 2022, the kWh price increased by 318% to 271.10 kurus for daily consumption of 30 kWh or less. (Price increase rates are calculated with reference to January 1, 2021).

In the Industrial Tariff Group;

On January 1, 2021, the kWh price of electricity was 73.82 kurus, while on January 1, 2022, the kWh price increased by 259% to 191.77 kurus. On October 1, 2022, the kWh price increased by 584% to 431.23 kurus. (Price increase rates are calculated with reference to January 1, 2021).

6. Conclusion

Information was given on the amount and installed capacity of renewable and other power plants in Turkey. In addition, by providing up-to-date information on electricity retail price tariffs, it was seen that the increase and fluctuation in these prices, industrial and commercial high power consuming subscribers, renewable energy power plants have benefited at the point of increasing the installed power. In the province of Amasya, TEDAŞ provided information about the installed capacity of substations and power plants and determined their position in comparison to Turkey. In addition, it is predicted that the demand and investments in this region continue, and the installed capacity will increase day by day.

On the other hand, it is clear that Amasya province has a significant potential in terms of renewable energy resources. For the effective use of this potential, the central administration should improve the relevant legislation and make it more flexible and facilitative in terms of capacity utilization.

Again, as clearly seen from the data above, there is a serious disorganization in energy prices and incentives. The relevant tariffs should be simpler, clearer and provide a balance in terms of competitiveness. Incentives for self-consumption should be increased.

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